Accuracy in Measuring Beta and Gamma Radiation

Comparison: GM Counting Tube vs. PIN Diode Sensor

GM Counting Tube
Principle: Gas discharge via impact ionization.
Sensitivity: Very high; detects individual particles.
Energy Response: High dependence; counts events without measuring energy.
Robustness/Price: Robust but requires high voltage (400–900V).
Application: Classic contamination monitoring.

PIN Diode Sensor
Principle: Each impact generates one charge carrier in a silicon crystal.
Sensitivity: Lower; detects individual particles, but often requires more measuring time.
Energy Response: Good; capable of spectroscopy with proper electronics.
Robustness/Price: Compact, inexpensive, low voltage requirement.
Application: Modern electronic dosimeters, cube satellites, wearables.

Calibration Procedure for Beta and Gamma Radiation

The calibration of radiation sensors ensures that the displayed values (dose rate or count rate) accurately reflect the actual radiation intensity. Calibration is performed in specialized labs using certified reference sources traceable to national standards.

1. Background Check & Zero Adjustment: The detector's internal noise (background) is measured without a source and subtracted from subsequent measurements.
2. Energy Calibration: The detector is tested for its response to specific radiation energies. Cesium-137 (662 keV) or Cobalt-60 are commonly used for gamma sensors.
3. Efficiency (Response) Calibration: The device is placed at precise distances from the source.
  - Beta Radiation: Geometry is critical (distance usually < 10–50 mm) because beta particles are easily absorbed by air.
  - Gamma Radiation: Field homogeneity across the detector surface must typically not vary by more than 5%.
4. Calibration Curves: Discrepancies between the source's nominal value and the device's reading are documented to calculate correction factors.

Accuracy Classes

Accuracy is defined by error limits that must be maintained across the entire measurement range.

Class ±20% (Standard Monitoring):
Typical for portable survey meters used in general safety. Calibration must occur at least two points per scale (usually at 20% and 80% of full scale) or one point per decade.

Class ±5% (Precision Measurement):
Required for scientific research or radiotherapy. Calibration requires at least 2000 counts (charge impacts) for each measurement. Requires strictly controlled environments (temperature, humidity). High-precision laser positioning and energy compensation filters are mandatory to flatten the sensor's natural response curve.